



# INTEGRATION OF NEPHROLITHIASIS RISK MODELING WITH MEDPRAT

Drayton Munster<sup>1</sup>

Michael Lovell<sup>2</sup>

Lauren McIntyre<sup>1</sup>

Larry Leinweber<sup>3</sup>

Jerry Myers<sup>1</sup>

Matthew Prelich<sup>1</sup>

Clara Gasiewski<sup>2</sup>

Mona Matar<sup>1</sup>

<sup>1</sup> NASA Glenn Research Center

<sup>2</sup> BQMI

<sup>3</sup> ZIN Technologies

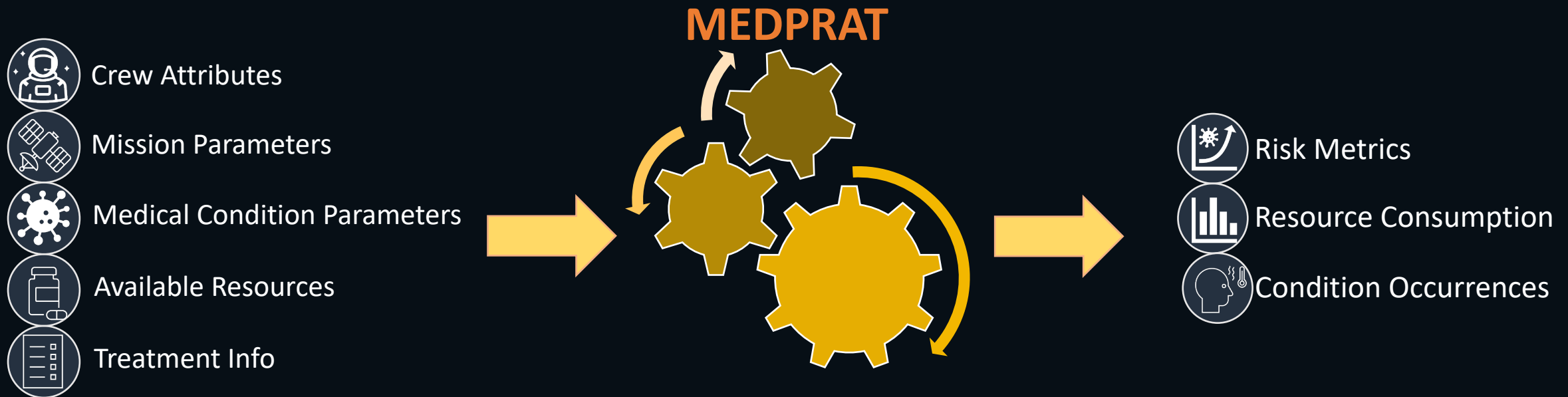


# Motivation

- Demonstrate *an* approach to incorporating external models with MEDPRAT, enabling us to:
  - Leverage existing work,
  - Improve model fidelity, and
  - Integrate with other risk quantification efforts.

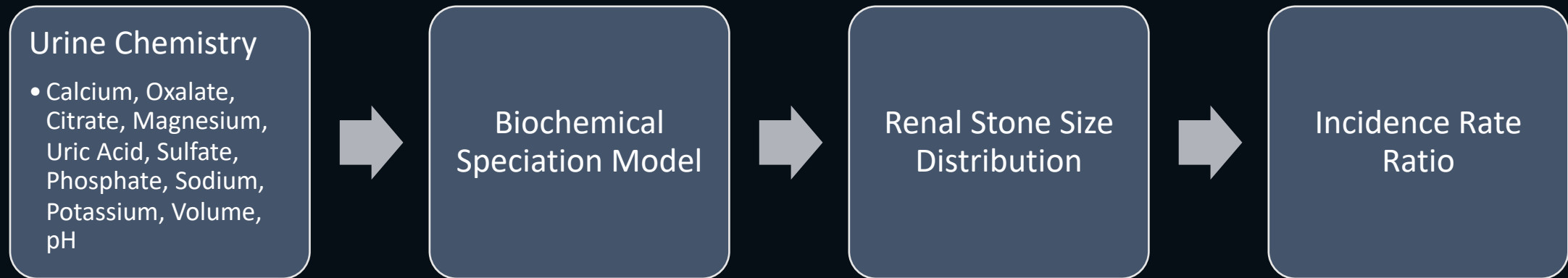
# MEDPRAT

- **M**edical **E**xtensible **D**ynamic **P**robabilistic **R**isk **A**ssessment **T**ool
- Computational model that simulates unplanned medical events during a mission to characterize space flight human health and performance risks.



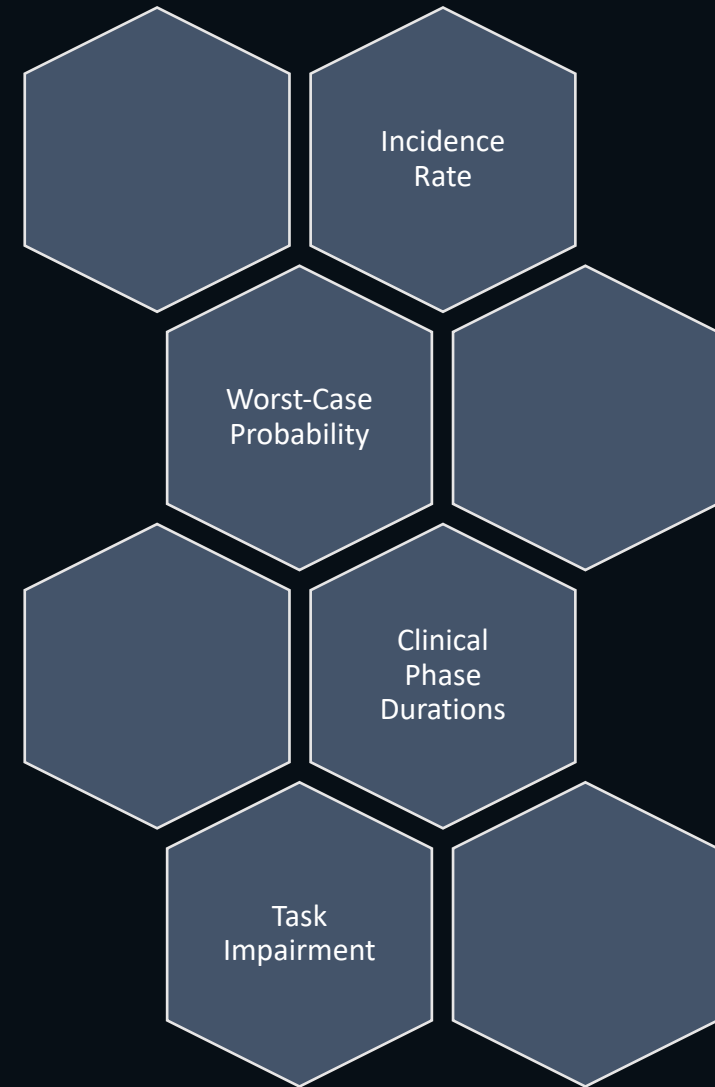
# Renal Stone Model

- Goodenow-Messman, D.A., Gokoglu, S.A., Kassemi, M. et al. Numerical characterization of astronaut CaOx renal stone incidence rates to quantify in-flight and post-flight relative risk. npj Microgravity 8, 2 (2022).



# Integration - Overview

- MEDPRAT offers many “knobs”.
  - Flexibility allows for many different types of models to be incorporated.
- Renal Model outputs Incident Rate Ratios (IRRs).
  - Integrate by scaling incidence rate for the nephrolithiasis condition.



# Integration – Challenges With Renal Model

## Computational

- Runtime
- Licensing

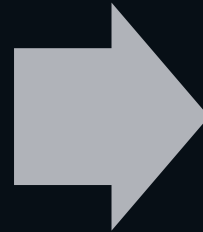
## Data

- Urine Chemistry Details
- Robustness

# Sampling

## Input Distributions

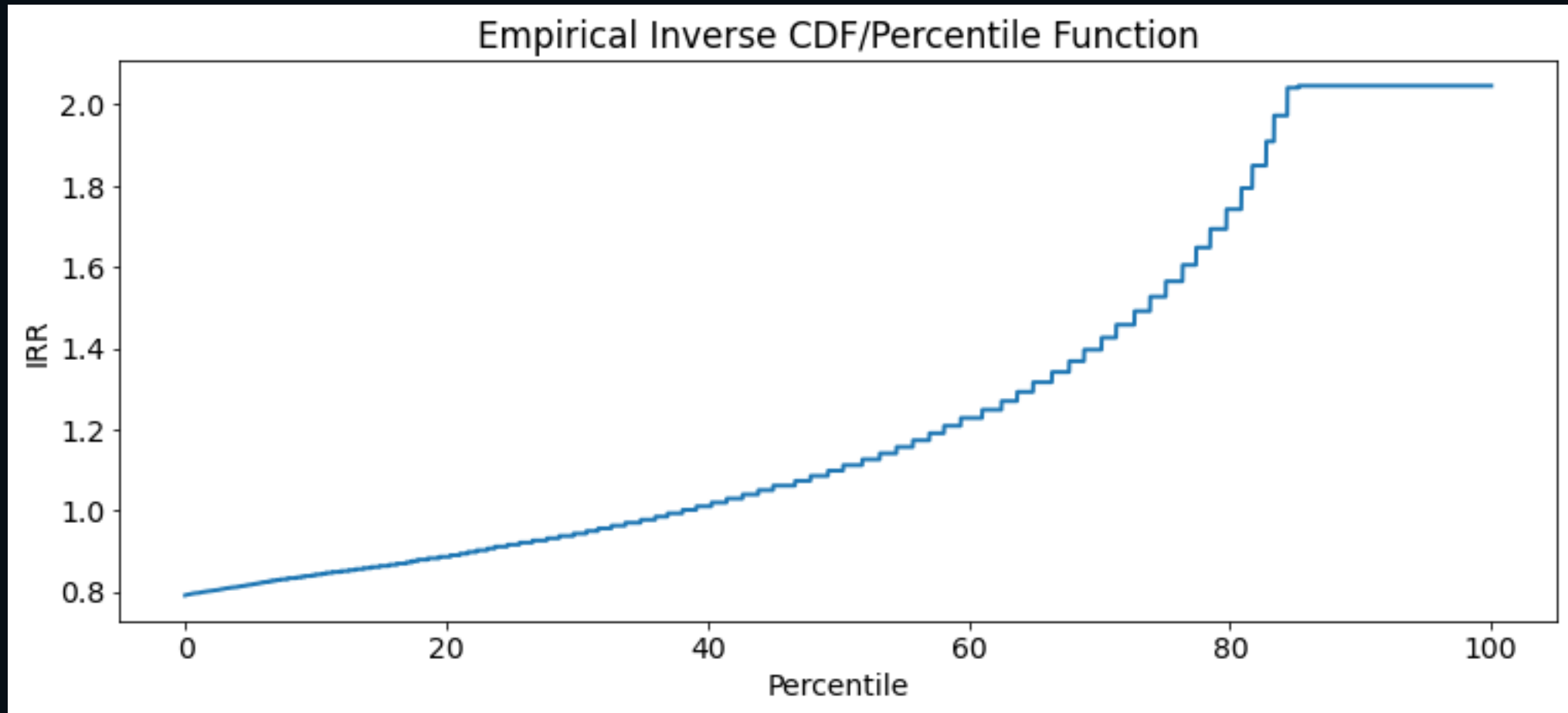
- Select subset of urine chemistry properties
  - Calcium
  - Volume
- Fill in remainder with samples drawn from a similar population



## IRR Distribution

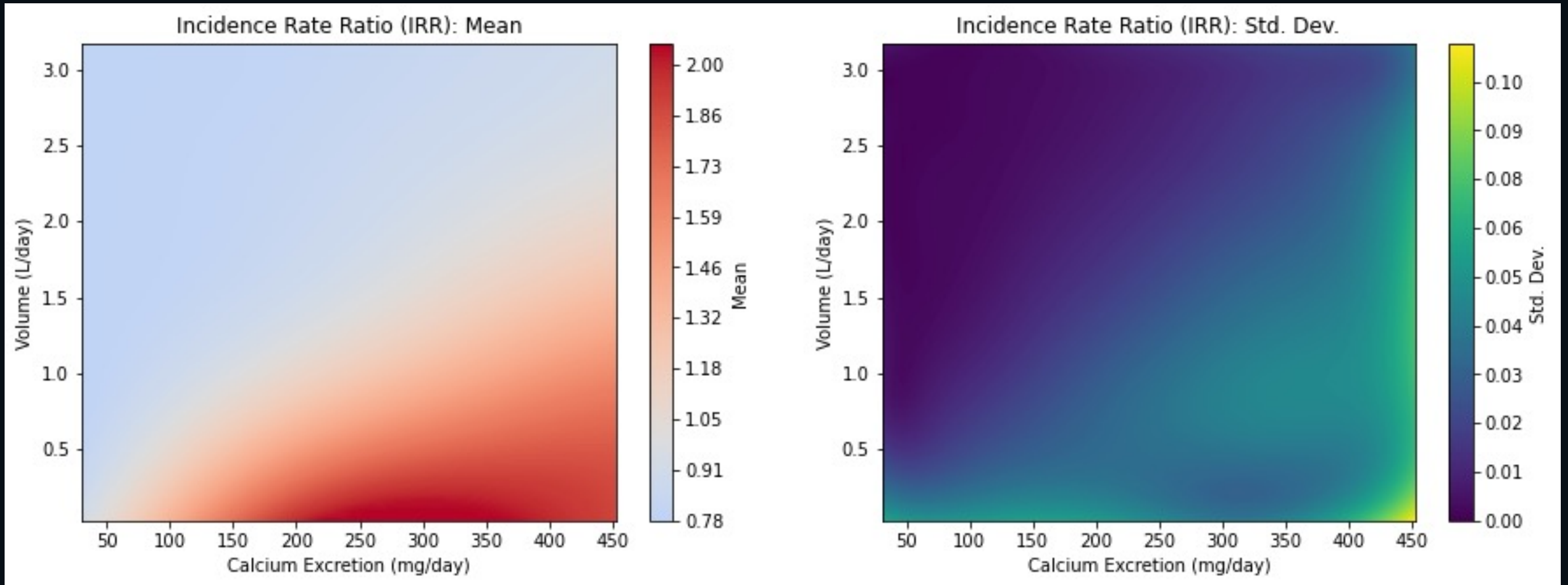
- Measure uncertainty in IRR
- Capture quantities of interest from distribution
  - Mean
  - Median
  - Quantiles

# IRR Distributions

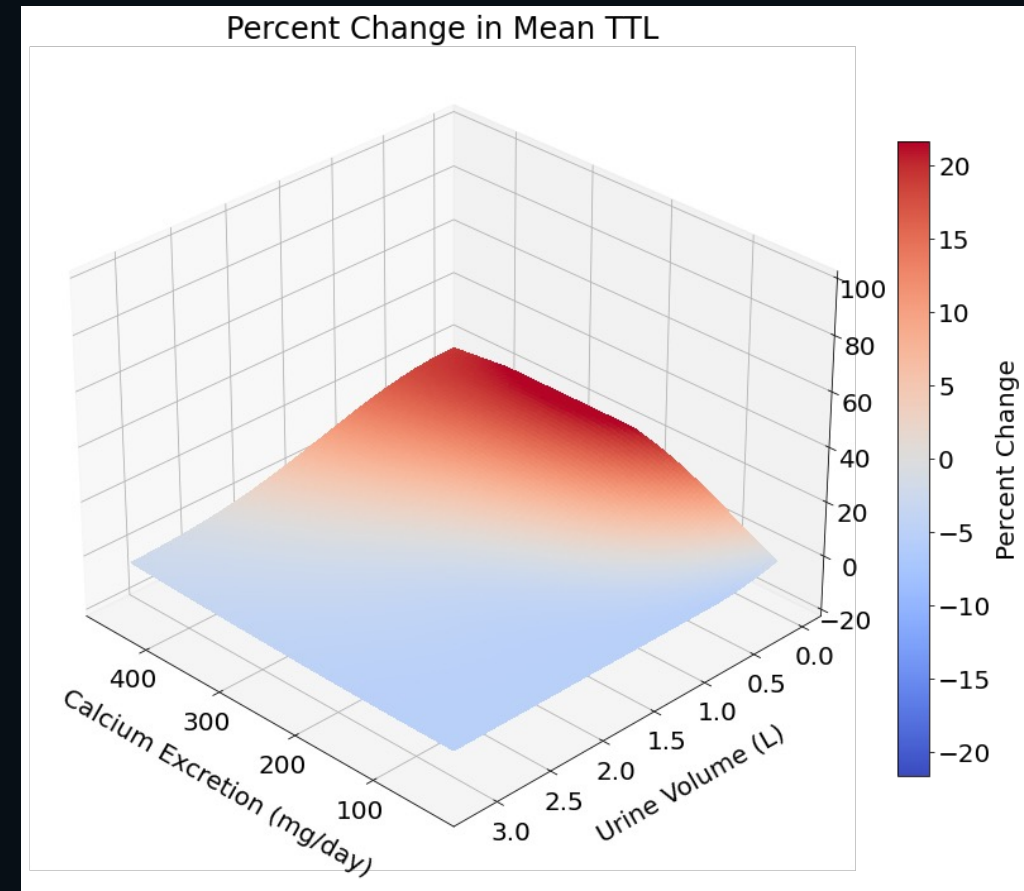
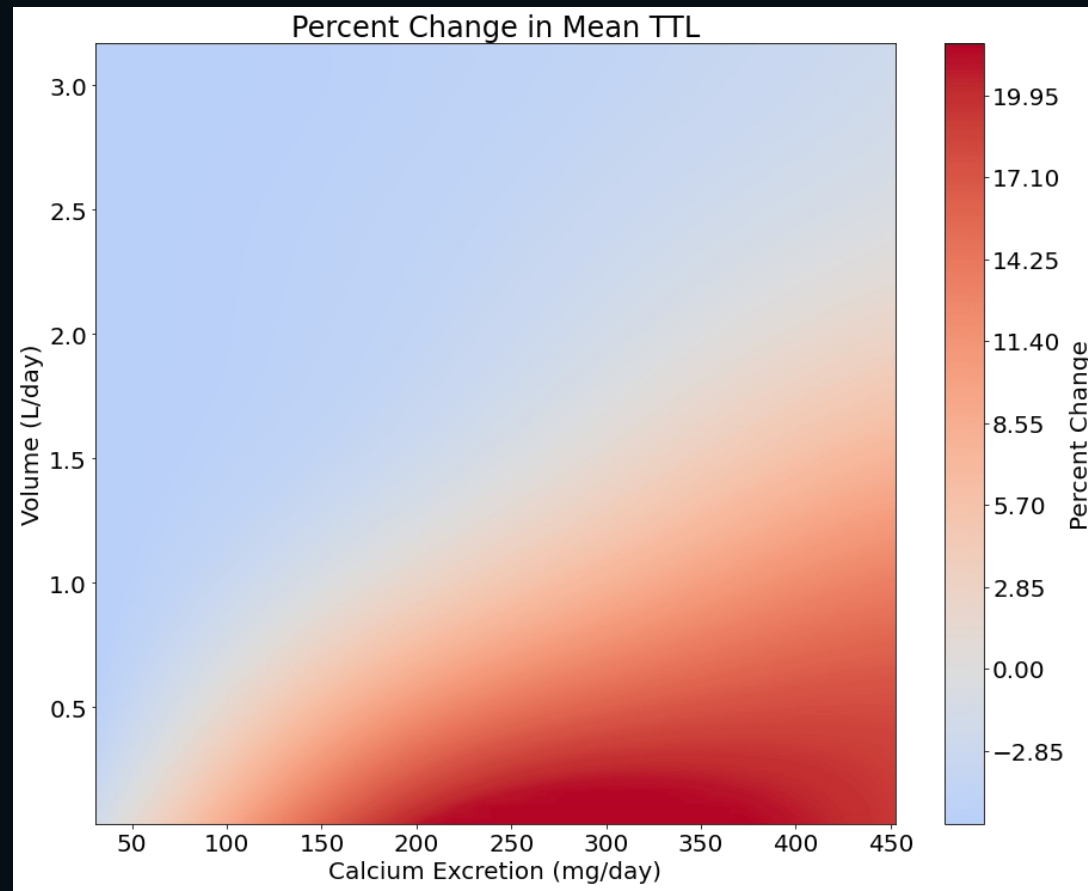




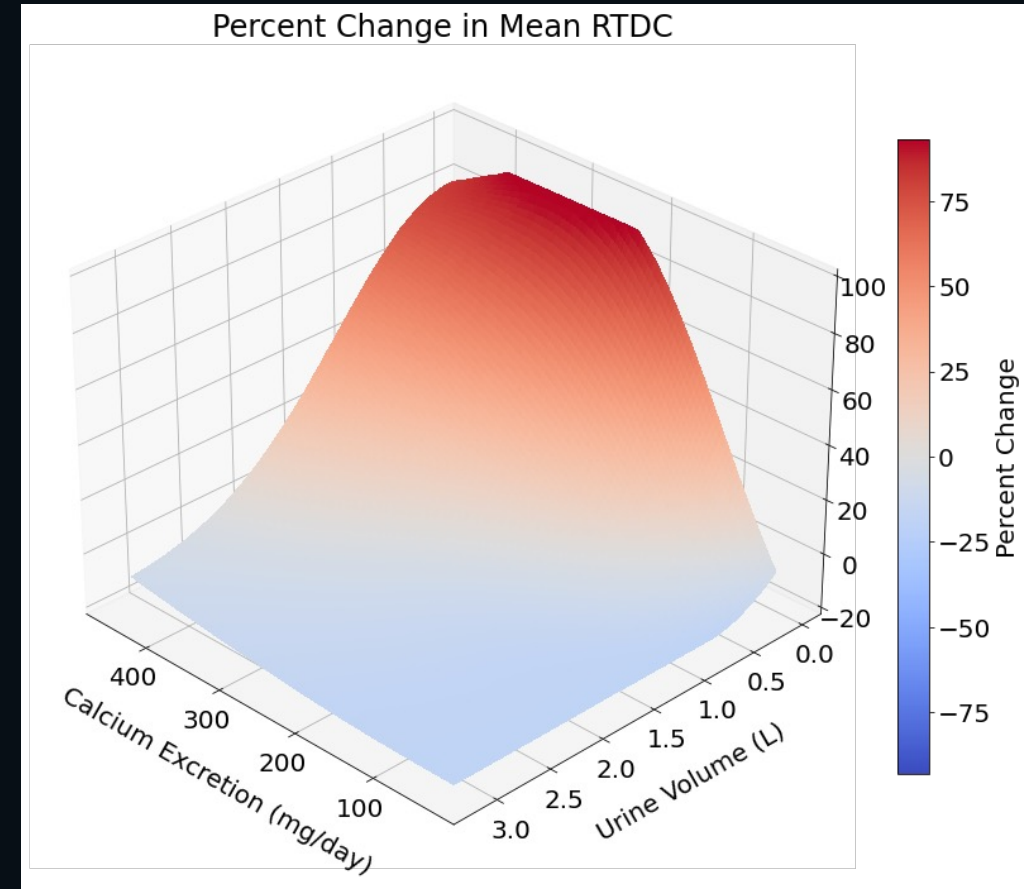
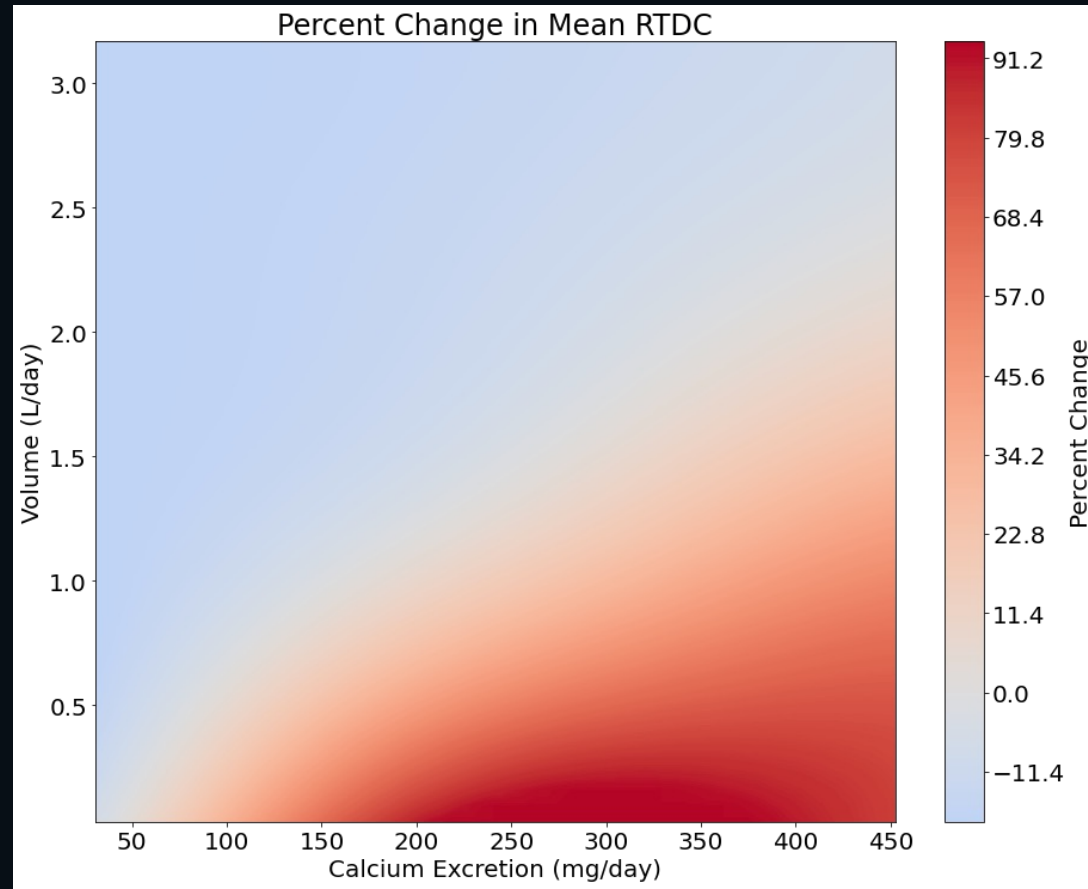
# Surrogate Model



# Change in Risk Metrics - TTL



# Change in Risk Metrics - RTDC





# Conclusions

- Demonstrated a technique for efficiently integrating the results of an external model with MEDPRAT via surrogate modeling of incident rate ratios.
- Incorporated the computed incidence rate changes to evaluate changes in risk metrics (TTL, RTDC).
- This surrogate model is then available for integration with other risk or capability models for holistic risk estimates.



# Thank You

Questions?